

# **Near-Surface Dispersion and Circulation in the Marmara Sea (MARMARA)**

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[http://poseidon.ogs.trieste.it/sire/drifter/marmara\\_main.html](http://poseidon.ogs.trieste.it/sire/drifter/marmara_main.html)

## **LONG-TERM GOALS**

To investigate the dynamics of semi-enclosed seas dominated by buoyancy input and wind forcing, and influenced by complex topography. To improve the understanding of coastal marine environmental evolution, with particular emphasis on eddy dynamics.

## **OBJECTIVES**

The main objective of the MARMARA project is to study the near-surface dispersion and circulation in the Marmara Sea, a small (70 x 250 km) basin connecting the Mediterranean Sea (through the Dardanelles Strait) to the Black Sea (via the Bosphorus Strait). It is planned to study the surface circulation dynamics of the Marmara Sea at scales from inertial/tidal to seasonal using drifter observations and ancillary satellite data (SST and ocean color) over about a year (from summer 2008 to spring 2009), in conjunction with other observational programs and numerical simulation exercises conducted by colleagues in the Turkish Straits System.

## **APPROACH**

Surface drifters will be deployed in two main episodes (in late summer 2008 and late winter 2009) at key locations to maximize the geographical coverage in the Marmara Sea and to construct maps of mean circulation and eddy variability, in terms of seasons and major wind regimes (Eulerian statistics). The deployments will mostly be in small (1 nm) clusters of three drifters in order to assess the horizontal dispersion of the surface waters (Lagrangian dispersion statistics). The drifter data will also be used in concert with satellite images (sea surface temperature and ocean color) to describe qualitatively the surface dynamics.

## **WORK COMPLETED**

Drifters of CODE design with Argos telemetry and GPS positioning (Fig. 1) were acquired from [Technocean](#) (Cape Coral, Florida, USA). The Technocean CODE drifters have been shown to follow the water within 2-3 cm/s even in strong wind/wave conditions.

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***Fig. 1. Photograph of a CODE drifter manufactured by Technocean. The GPS (left) and Argos (right) antennas are clearly visible at the top of the drifter..***

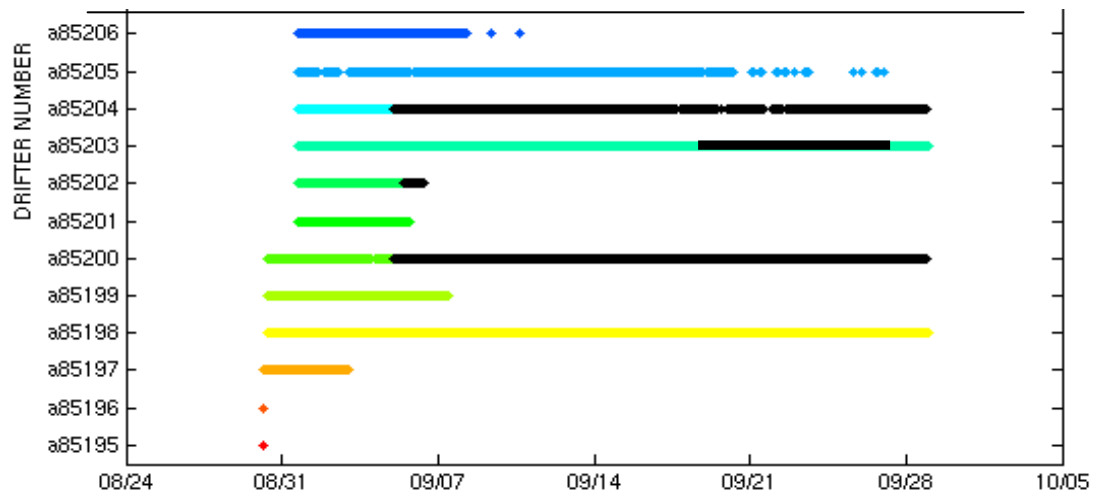
In total, 12 drifters were deployed in the Marmara Sea on 30/31 August 2008 as part as the TSS08 trial of the NATO Undersea Research Centre (NURC). They were deployed in triplets in which drifters are separated by about 1 nm. Two triplets were deployed on 30 August 2008 in the central open sea near longitude 28°E. On 31 August 2008, two other triplets were released south of the Bosphorus in the northeastern Marmara Sea. The data of these drifters are processed in near-real time and graphics with trajectories and status tables are posted on the web

([http://doga.ogs.trieste.it/sire/drifter/tss08/tss08\\_marmara.html](http://doga.ogs.trieste.it/sire/drifter/tss08/tss08_marmara.html)).

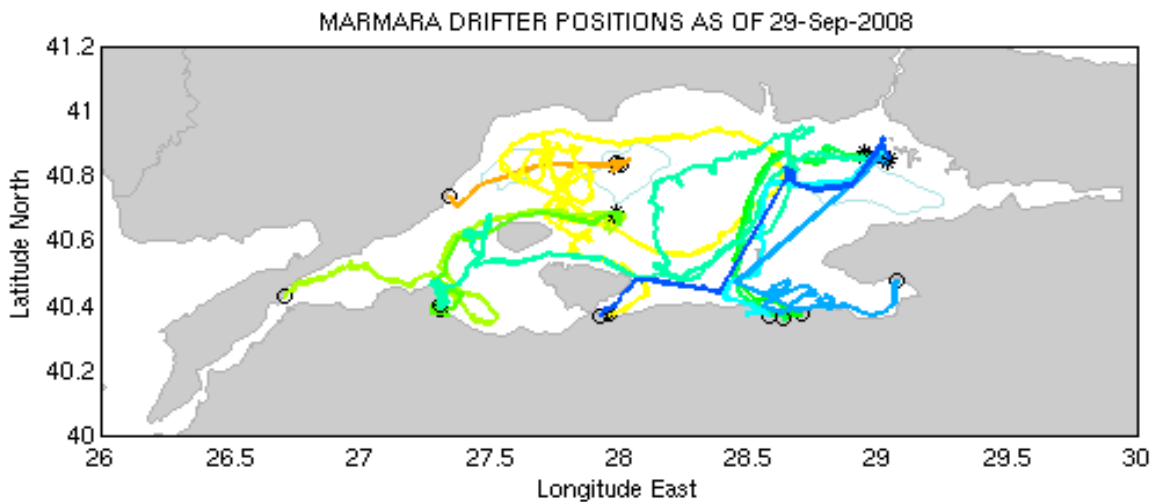
## **RESULTS**

Out of 12 drifters, two units failed to transmit right after deployment (see Fig. 2). Given the relatively small size of the Marmara Sea and the high probability of pick-up by seafarers, the operating lives of the drifters are rather short. For example, five drifters provided data for 3-4 days before stranding or being picked-up. In less than a month, 7 drifters ended up on the southern coast. One lucky unit (Argos number 85198) is still drifting with the currents as of 29 September, that is about a month after deployment. Its trajectory shows intricate loop motions in addition to a basin-wide anticyclonic circulation (yellow trajectory in Fig. 3).

As expected, the drifters reveal a general surface flow to the southwest in the Marmara Sea, connecting the Bosphorus to the Dardanelles (see trajectories in Fig. 3). Contrasting this mean circulation picture, two drifters (85198 and 85203) followed a basin-wide anticyclonic flow pattern with eastward currents prevailing to the north. Smaller meandering and looping drifter trajectory segments indicate the existence of mesoscale circulation features and inertial oscillation motions throughout the basin.



**Fig. 2. Timelines of the CODE drifters deployed in the Marmara Sea on 30/31 August 2008, updated as of 29 September 2008. Black lines indicate stranded drifters.**



**Fig. 3. Trajectories of the CODE drifters deployed in the Marmara Sea on 30/31 August 2008. Deployment locations are depicted with star symbols whereas open circles indicated the last fixes (stranded or still active in water on 29 September 2008).**

## IMPACT/APPLICATION

The scientific impact of this project is to increase our understanding of the Marmara Sea dynamics and of its major forcing mechanisms. Future application could be the validation of diagnostic numerical models and the assimilation of the drifter data into prognostic numerical models in the framework of operational oceanography projects.

## RELATED PROJECTS

The MARMARA project is strongly related to, and fully integrated in, projects carried by the Naval Research Laboratory (NRL), NURC and the University of Miami in the Turkish Strait System (Northeastern Aegean, Marmara and Southwestern Black seas).

These programs include:

- The TSS08 project conducted by NURC (P.I. Dr. S. Besiktepe)  
(<http://geos2.nurc.nato.int/tss08/html/home.html> ).
- The NRL Exchange Processes in Ocean Straits (EPOS) project to improve our understanding on the significance of synoptic variability to exchange dynamics in ocean straits (P. I.s: Drs. J. Book and E. Jarosz).
- Development of a multi-scale coupled ocean model system for the Turkish Strait System by NRL (P. I.: Dr. C. A. Blain).
- Coastal and shelf modeling activities carried out at the Rosenstiel School of Marine and Atmospheric Science (University of Miami) (P.I. Dr. V. Kourafalou).  
([http://coastalmodeling.rsmas.miami.edu/Models/View/AEGEAN\\_SEA](http://coastalmodeling.rsmas.miami.edu/Models/View/AEGEAN_SEA) )